(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2002－198069
（P2002－198069A）
(43)公開日　平成14年７月12日(2002.7.12)

(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード（参考）
Ｈ０１Ｍ　8/02		Ｈ０１Ｍ　8/02		Ｒ　５Ｈ０２６
				Ｃ　５Ｈ０２７
8/06		8/06		Ｗ
8/10		8/10		

審査請求　未請求　請求項の数７　ＯＬ　（全７頁）

(21)出願番号　特願2000－392177(P2000－392177)

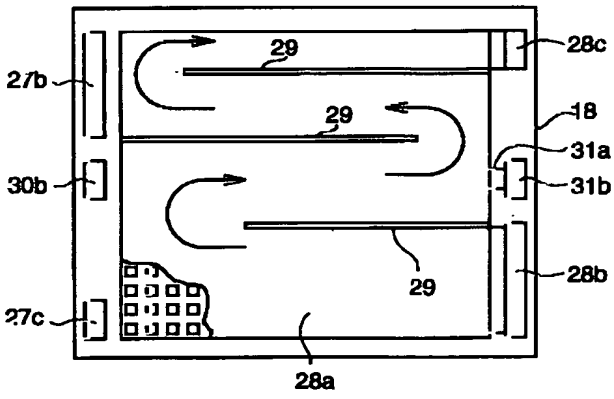
(22)出願日　平成12年12月25日(2000.12.25)

(71)出願人　000003207
トヨタ自動車株式会社
愛知県豊田市トヨタ町１番地
(72)発明者　高橋　剛
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内
(72)発明者　鈴木　稔幸
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内
(74)代理人　100083091
弁理士　田渕　経雄

最終頁に続く

(54)【発明の名称】　燃料電池

(57)【要約】
【課題】　ガス流路の凝縮水の排水性を改善した燃料電池の提供。
【解決手段】　（１）セパレータ面を上下方向に向け、セパレータ１８の電極との接触面に酸化ガスあるいは燃料ガスのガス流路２７、２８を設けた燃料電池１０において、ガス流路２７、２８のガス入口、ガス出口以外の途中の位置に、ガス流路に溜まる水を燃料電池外に排出可能な排水通路３０、３１を開口させた燃料電池１０。（２）排水通路３０、３１に開閉可能なバルブ３２を設けた燃料電池。（３）燃料電池の運転状態に応じてバルブ３２を開閉制御するバルブ開閉制御装置３３を設けた燃料電池。（４）酸化ガスあるいは燃料ガスのガス流路のうちガスが下方から上方に流れるガス流路に排水通路３０、３１を設けた燃料電池。



【特許請求の範囲】
【請求項1】 セパレータ面を上下方向に向け、セパレータの電極との接触面に酸化ガスあるいは燃料ガスのガス流路を設けた燃料電池において、前記ガス流路のガス入口、ガス出口以外の途中の位置に、ガス流路に溜まる水を燃料電池外に排出可能な排水通路を開口させたことを特徴とする燃料電池。
【請求項2】 前記排水通路に開閉可能なバルブを設けた請求項1記載の燃料電池。
【請求項3】 燃料電池の運転状態に応じて前記バルブを開閉制御するバルブ開閉制御装置を設けた請求項2記載の燃料電池。
【請求項4】 酸化ガスあるいは燃料ガスのガス流路のうちガスが下方から上方に流れるガス流路に前記排水通路を設けた請求項1記載の燃料電池。
【請求項5】 酸化ガスあるいは燃料ガスのガス流路のうち一方のガス流路ではガスが下方から上方に流れ、他方のガス流路ではガスが上方から下方に流れ、前記ガスが下方から上方に流れるガス流路に前記排水通路を設けた請求項4記載の燃料電池。
【請求項6】 ガス流路を上流から下流に向けて絞った請求項1記載の燃料電池。
【請求項7】 冷媒流路を有し、酸化ガス流路ではガスが下方から上方に流れ、冷媒流路では冷媒が下方から上方に流れる請求項1記載の燃料電池。
【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、燃料電池に関し、とくに固体高分子電解質型燃料電池の生成水の排出を良好にした燃料電池に関する。
【0002】
【従来の技術】固体高分子電解質型燃料電池は、イオン交換膜からなる電解質膜とこの電解質膜の一面に配置された触媒層および拡散層からなる電極（アノード、燃料極）および電解質膜の他面に配置された触媒層および拡散層からなる電極（カソード、空気極）とからなる膜－電極アッセンブリ（ＭＥＡ：Membrane-Electrode Assembly）と、アノード、カソードに燃料ガス（水素）および酸化ガス（酸素、通常は空気）を供給するための流体通路を形成するセパレータとからセルを構成し、複数のセルを積層してモジュールとし、モジュールを積層してモジュール群を構成し、モジュール群のセル積層方向両端に、ターミナル、インシュレータ、エンドプレートを配置してスタックを構成し、スタックをセル積層体積層方向に延びる締結部材（たとえば、テンションプレート）にて締め付け、固定したものからなる。固体高分子電解質型燃料電池では、アノード側では、水素を水素イオンと電子にする反応が行われ、水素イオンは電解質膜中をカソード側に移動し、カソード側では酸素と水素イオンおよび電子（隣りのＭＥＡのアノードで生成した電子がセパレータを通してくる）から水を生成する反応が行われる。
アノード側：$H_2 \rightarrow 2H^+ + 2e^-$
カソード側：$2H^+ + 2e^- + (1/2)O_2 \rightarrow H_2O$
カソードでの水生成反応で出る熱とジュール熱とによりセルの温度が上昇するので、セパレータ間には、各セル毎にあるいは複数個のセル毎に、冷媒（通常は冷却水）が流れる冷媒流路が形成されており、燃料電池を冷却している。酸化ガスは、入口側で乾燥（ドライ）しやすく途中で反応生成水で湿潤されていき出口側で湿潤過多（フラッディング）を生じやすい。また、燃料ガスは、電解質膜を通して酸化ガスの水分が拡散してくるので、燃料ガス出口側が入口側より湿潤状態になる。燃料電池で水素イオンが電解質膜中を移行して上記の発電反応が円滑に行われるためには、電解質膜が適度の水分を含んでいなければならない。また、電解質膜の全域で正常な発電反応が行われるには、セル面内方向に水分分布が均一化されることが必要である。何となれば、水分分布が偏って電解質膜が局部的に乾燥すると上記発電反応が得られなくなるからであり、また反応による生成水によって湿潤過多となると、生成・凝縮した水滴によって酸化ガスのカソードへの酸素の供給が阻止されるからである。特開２０００－８２４８２は、ガス流入孔からガス流出孔までの気流によって、凝縮水が流出方向に排出され得る、サーペンタイン（蛇行）型のガス供給流路をもつ固体高分子型燃料電池を開示している。
【0003】
【発明が解決しようとする課題】しかし、上記の従来燃料電池では、ガス流路が長くなると、凝縮水が流出孔まで到達するのが難しくなる。特に流出孔まで凝縮水が自重落下できるような傾斜が設けられていないガス流路をもつセパレータでは、その排水性悪化が顕著になる。本発明の目的は、ガス流路の凝縮水の排水性を改善した燃料電池を提供することにある。
【0004】
【課題を解決するための手段】上記目的を達成する本発明はつぎの通りである。
（１） セパレータ面を上下方向に向け、セパレータの電極との接触面に酸化ガスあるいは燃料ガスのガス流路を設けた燃料電池において、前記ガス流路のガス入口、ガス出口以外の途中の位置に、ガス流路に溜まる水を燃料電池外に排水可能な排水通路を開口させたことを特徴とする燃料電池。
（２） 前記排水通路に開閉可能なバルブを設けた（１）記載の燃料電池。
（３） 燃料電池の運転状態に応じて前記バルブを開閉制御するバルブ開閉制御装置を設けた（２）記載の燃料電池。
（４） 酸化ガスあるいは燃料ガスのガス流路のうちガスが下方から上方に流れるガス流路に前記排水通路を設

けた（１）記載の燃料電池。
（５）　酸化ガスあるいは燃料ガスのガス流路のうち一方のガス流路ではガスが下方から上方に流れ、他方のガス流路ではガスが上方から下方に流れ、前記ガスが下方から上方に流れるガス流路に前記排水通路を設けた
（１）記載の燃料電池。
（６）　ガス流路を上流から下流に向けて絞った請求項１記載の燃料電池。
（７）　冷媒流路を有し、酸化ガス流路ではガスが下方から上方に流れ、冷媒流路では冷媒が下方から上方に流れる請求項１記載の燃料電池。
【０００５】上記（１）の燃料電池では、排水通路を設けたので、排水通路を介して凝縮水を排出でき、排水性を改善できる。また、セパレータ面を上下方向に向けたので、たとえガス流路内に水滴が生じても、重力でガス流路を下方に流れ、セル面全域が水分により覆われることは起こらない。上記（２）の燃料電池では、排水通路にバルブを設けたので、排水時以外はバルブを閉にしておくことにより、ガスが排水通路を介して系外に排出されることを防止でき、かつ排水時も系外に排出されるガス量を制御でき、これらによって、ガス流路におけるガス流速低下を最小限にすることができる。上記（３）の燃料電池では、燃料電池の運転状態に応じてバルブを開閉制御するバルブ開閉制御装置を設けたので、燃料電池の運転状態に応じた最適な排水を行うことができる。上記（４）の燃料電池では、下方から上方に流れるガス流路に排水通路を設けたので、水に重力と反対方向にガス流が作用してガス流路の途中に水がたまっても、排水通路により効率よく排水することができる。また、重力とガス流が同じ方向に作用して効率よくガス出口から排水できる流路には、排水通路を必ずしも設けなくてもよく、排水通路によるセル構造の複雑化を最小限にすることができる。上記（５）の燃料電池では、上記（４）の燃料電池において、酸化ガスと燃料ガスをＭＥＡの表裏で互いに対向させて流したので、上記（４）の作用に加えて、アノード側とカソード側の反応面における湿度分布が互いに逆分布となり、水分が、電解質膜を通して、酸化ガス出口部近傍から燃料ガス入口部近傍に、さらに燃料ガス出口部近傍から酸化ガス入口部近傍（酸化ガス入口部近傍は最も乾きやすい部位である）に拡散、移行し、セル内を水分が循環して、水分分布の均一化、フラッディング防止（最も湿潤過多になる酸化ガス出口部近傍のフラッディング防止）がはかられるという作用が得られる。上記（６）の燃料電池では、ガス流路を上流側から下流側に向けて絞ったので、ガス流速が速くなる、または水生成反応におけるガス消費によるガス流速の低減が抑制される。早められたガス流速によって、ガス流路の途中にたまった水の、該水より下流側にある、ガス出口または排水通路への排水性がよくなる。上記（７）の燃料電池では、酸化ガス流路ではガスが下方から上方に流れ、冷媒流路では冷媒が下方から上方に流れるので、最も乾きやすい酸化ガス流路入口近傍の温度を最も下げることができ、酸化ガス流路入口近傍の飽和蒸気圧を下げて乾きにくくすることができる。また、冷媒流路内に気泡が生じても、浮力によって上方にある冷媒出口へと向かうので、冷媒流路の気泡（ガス溜まり）によるガスロックを防止することができる。冷媒を上から入れて下に流すとガス溜まりができた時にガスロックしうるが、それを防止することができる。
【０００６】
【発明の実施の形態】以下に、本発明の燃料電池を図１～図６を参照して、説明する。図１～図４は本発明の何れの実施例にも適用可能であり、図５は本発明の実施例１を示し、図６は本発明の実施例２を示す。本発明の全実施例にわたって共通する部分には、本発明の全実施例にわたって同じ符号を付してある。まず、本発明の全実施例にわたって共通する部分または共通に適用可能な部分を、図１～図４を参照して説明する。本発明の燃料電池は固体高分子電解質型燃料電池１０である。本発明の燃料電池１０は、たとえば燃料電池自動車に搭載される。ただし、自動車以外に用いられてもよい。
【０００７】固体高分子電解質型燃料電池１０は、図１、図２に示すように、イオン交換膜からなる電解質膜１１とこの電解質膜１１の一面に配置された触媒層１２および拡散層１３からなる電極１４（アノード、燃料極）および電解質膜１１の他面に配置された触媒層１５および拡散層１６からなる電極１７（カソード、空気極）とからなる膜－電極アッセンブリ（ＭＥＡ：Membrane-Electrode Assembly ）と、電極１４、１７に燃料ガス（水素）および酸化ガス（酸素、通常は空気）を供給するための反応ガス流路２７（単に、ガス流路ともいう）および燃料電池冷却用の冷媒（通常は冷却水）が流れる冷媒流路２６（冷却水流路ともいう）を形成するセパレータ１８とを重ねてセルを形成し、該セルを複数積層してモジュール１９とし、モジュール１９を積層してモジュール群を構成し、モジュール１９群のセル積層方向（燃料電池積層方向）両端に、ターミナル２０、インシュレータ２１、エンドプレート２２を配置してスタック２３を構成し、スタック２３を積層方向に締め付けスタック２３の外側で燃料電池積層体積層方向に延びる締結部材２４（たとえば、テンションプレート）とボルト２５で固定したものからなる。
【０００８】燃料電池１０は、セル積層方向を重力と垂直方向にして、配置される。したがって、セル面、セパレータ面は鉛直方向（上下方向）に向けられている。冷媒流路２６はセル毎に、または複数のセル毎に、設けられる。たとえば、２つのセル毎に１つの冷媒流路２６が設けられる。冷媒流路２６には冷媒、たとえば冷却水が流れる。
【０００９】セパレータ１８は、燃料ガスと酸化ガス、

燃料ガスと冷却水、酸化ガスと冷却水、の何れかを区画するとともに、隣り合うセルのアノードからカソードに電子が流れる電気の通路を形成している。セパレータ１８は、カーボン板に冷媒流路２６やガス流路２７を形成したもの、または、導電性粒子を混入して導電性をもたせた樹脂板に冷媒流路２６やガス流路２７、２８を形成したもの、または、冷媒流路２６、ガス流路２７、２８を形成する凹凸のある金属板またはそれを複数枚重ね合わせたもの、の何れかからなる。各ガス流路２７、２８は、図示例のように複数の突起により隔てられた２枚の平板の間のスペース（格子状流路）であってもよいし、互いに並行する複数のガス流路からなるガス流路群であってもよい。ただし、排水性の点から格子状流路が望ましい。ガス流路２７、２８は、流路長、流速をかせぐためにたとえばサーペンタイン（蛇行）流路からなり、流路の折り返し部を除き流路は水平かほぼ水平、または上下方向に延び、隣接する流路は流路の折り返し部を除き仕切壁２９で仕切られていることが望ましい。

【００１０】ガス流路２７、２８は、燃料ガスが流れる燃料ガス流路２７と酸化ガスが流れる酸化ガス流路２８とからなる。燃料ガス流路２７はＭＥＡの一側に、酸化ガス流路２８はＭＥＡの他側に設けられる。したがって、燃料ガス流路２７と酸化ガス流路２８とは、ＭＥＡを挟んで、ＭＥＡの表裏に位置する。セルの燃料ガス流路２７は、燃料ガス流路２７ａと、燃料ガス流路２７ａへの燃料ガス入口２７ｂと、燃料ガス流路２７ａからの燃料ガス出口２７ｃと、からなる。同様に、セルの酸化ガス流路２８は、酸化ガス流路２８ａと、酸化ガス流路２８ａへの酸化ガス入口２８ｂと、酸化ガス流路２８ａからの酸化ガス出口２８ｃと、からなる。

【００１１】ガス流路２７のガス入口２７ｂ、ガス出口２７ｃ以外の途中の位置に、ガス流路２７ａに溜まる水を燃料電池１０外に排出可能な排水通路３０が開口されている。同様に、ガス流路２８のガス入口２８ｂ、ガス出口２８ｃ以外の途中の位置に、ガス流路２８ａに溜まる水を燃料電池１０外に排出可能な排水通路３１が開口されている。排水通路３０、３１は、ガス流路２７ａ、２８ａから分岐して排水マニホールド３０ｂ、３１ｂまで延びる分岐流路３０ａ、３１ａ、セル積層方向に延びて各セルの分岐流路３０ａ、３１ａを集める排水マニホールド３０ｂ、３１ｂ、および一端が排水マニホールド３０ｂ、３１ｂに接続し、他端が系外に接続または開放する排水ホース３０ｃ、３１ｃを有する。

【００１２】排水通路３０、３１には、たとえば排水ホース３０ｃ、３１ｃには、排水通路３０、３１を開閉可能なバルブ３２が設けられており、あるタイミングでバルブ３２が開放されることにより、排水（ガスと共の排水）が実施される。排水通路３０、３１は互いに独立であるが、バルブ３２より系外側は共通でもよい。バルブ３２より系外側で排水ホース３０ｃ、３１ｃを共通とする場合は排水通路３０、３１のバルブ３２は、水素とエアまたは酸素との混じりを防止するために、時間をずらして開とするようにする。

【００１３】燃料電池１０の運転状態に応じてバルブ３２を開閉制御するバルブ開閉制御装置３３が設けられている。バルブ開閉制御装置３３は、たとえばＥＣＵ（Electronic Control Unit)からなる。ＥＣＵは、時間（たとえば、一定時間毎に抜く）、燃料電池の運転条件、負荷（負荷が小さければ間隔を長くする）、湿度（湿度大だと水抜きのタイミングを早める）、圧力（圧力が低い方が流速が速いので水を抜きやすいので、水抜きのタイミングは長くてもよい）、温度（セル温度が低いと凝縮しやすいので、バルブ３２の開タイミングを早める）、等により、予め設定されたマップ、もしくはこれらのデータより水量を算出し、適正なタイミングでバルブ３２を開き、セパレータ面内の水を系外に排水する。バルブ３２開によりガスも排出されるので、一瞬ガス流路２７、２８の流速が増し、それによってもガス流路２７、２８内の反応生成水が排出され、電極へのガスの供給が改善され、燃料電池１０の性能が改善される。

【００１４】排水通路３０、３１は、燃料ガス流路２７あるいは酸化ガス流路２８のうちガスが下方から上方に流れるガス流路（ガス入口がガス出口より下にあるガス流路）に設けられる。ただし、排水通路３０、３１は、ガスが上方から下方に流れるガス流路にも設けられてもよい。たとえば、酸化ガスあるいは燃料ガスのガス流路２７、２８のうち一方のガス流路ではガスが下方から上方に流れ、他方のガス流路ではガスが上方から下方に流れる場合、排水通路３０、３１はガスが下方から上方に流れるガス流路（ガス入口がガス出口より下にあるガス流路）に設けられる。

【００１５】燃料ガス流路２７あるいは酸化ガス流路２８も上流から下流に向けて絞られている。反応生成水の生成につれて燃料ガスおよび酸化ガスが消費されるので、ガス流路では下流側にいくにしたがってガス流速が遅くなろうとするので、ガス流速の低下を少なくするかまたは逆にガス流速を増すように、ガス流路２７、２８の通路断面積が下流側に向けて徐々にまたは段階的に絞られている。この通路断面積の絞りは、ガス流路２７の幅、または深さを下流側に向けて徐々にまたは段階的に小にすることによって得られる。

【００１６】冷媒流路２６のガスロック（冷媒流路２６で生じたまたは混入したガスにより流路が閉塞されて冷媒が流れなくなる現象）を防止するに、冷媒流路２６でガスが浮力により浮上する時に冷媒の流れがそれを妨げないように、冷媒流路２６では、冷媒が下から上に流される（冷媒入口が冷媒出口より下にある）ことが望ましい。ただし、冷媒は上から下に流されてもよい。冷媒が下から上に流される場合、酸化ガスも下から上に流されることが望ましい。そうすることによって、酸化ガス入

口と冷媒入口を対応させることができ、最も乾きやすい酸化ガス入口を低温の冷媒で冷却することができ、酸化ガス入口近傍の飽和蒸気圧を下げてその近傍の電解質膜のドライアップを抑制することができる。ただし、冷媒の流れ方向と酸化ガスの流れ方向を対向させてもよい。

【００１７】燃料ガスと酸化ガスの流れ方向は互いに対向することが望ましい。すなわち、アノード側とカソード側の反応面における湿度分布が互いに逆分布となるように、燃料ガスの供給口２７ｂ、排出口２７ｃ、およびガス流路２７ａおよび酸化ガスの供給口２８ｂ、排出口２８ｃ、およびガス流路２８ａが配置されている。また、セルの燃料ガス流路２７ａと酸化ガス流路２８ａとは、互いに平行である。そして、セルの燃料ガス流路２７ａの上流側（燃料ガス流路２７ａの中間点より燃料ガス流れ方向上流側）と酸化ガス流路２８ａの下流側（酸化ガス流路２８ａの中間点より酸化ガス流れ方向下流側）とが対応させて設けられ、セルの燃料ガス流路２７ａの下流側（燃料ガス流路２７ａの中間点より燃料ガス流れ方向下流側）と酸化ガス流路２８ａの上流側（酸化ガス流路２８ａの中間点より酸化ガス流れ方向上流側）とが対応させて設けられる。

【００１８】本発明の全実施例に共通または適用可能な上記構成の作用を説明する。排水通路３０、３１を設けたので、あるタイミングでバルブ３２を開にして、排水通路３０、３１を介してガス流路２７、２８の途中の凝縮水を系外に排出でき、排水性を改善できる。これによって、燃料電池１０の出力性能のよい連続運転が可能になる。また、セパレータ面を上下方向に向けたので、たとえガス流路内に水滴が生じても、重力でガス流路を下方に流れ、排出性がよく、セル面が水平配置される場合に起こり得るセル面全域が水分により覆われる事態は起こらない。

【００１９】また、排水通路３０、３１にバルブ３２を設けたので、排水実行時以外はバルブ３２を閉にしておくことにより、燃料ガス、酸化ガスが排水通路を介して系外に排出されることを防止でき、かつ排水時も系外に排出されるガス量を制御でき、これらによって、ガス流路２７、２８におけるガス流速低下を最小限にすることができる。バルブ３２はバルブ開閉制御装置３３により燃料電池の運転状態に応じて開閉制御されるので、燃料電池の運転状態に応じた最適な排水を行うことができる。

【００２０】ガスが下方から上方に流れるガス流路に排水通路を設けた場合、ガス流路に生じた水には重力と反対方向にガス流が作用するので、ガス流路の途中に水がたまりやすくなるが、ガス流路の途中に水がたまっても、排水通路３０、３１により効率よく排水することができる。また、重力とガス流が同じ方向に作用して効率よくガス出口から排水できるガス流路には、排水通路を必ずしも設けなくてもよく、排水通路を設けたことによるセル構造の複雑化（排水マニホールドをもうけなくてはならないので、ガスマニホールドや冷媒マニホールドを設けるスペースが制限され、構造が複雑化すること）を最小限にすることができる。

【００２１】酸化ガスと燃料ガスをＭＥＡの表裏で互いに対向させて流した場合は、アノード側とカソード側の反応面における湿度分布が互いに逆分布となり、水分が、電解質膜１１を通して、酸化ガス出口部近傍から燃料ガス入口部近傍に、さらに燃料ガス出口部近傍から酸化ガス入口部近傍（酸化ガス入口部近傍は最も乾きやすい部位である）に拡散、移行し、セル内を水分が循環して、水分分布の均一化、フラッディング防止（最も湿潤過多になる酸化ガス出口部近傍のフラッディング防止）がはかられる。

【００２２】また、ガス流路２７、２８が上流側から下流側に向けて絞られているので、ガス流速が速くなる、または水生成反応におけるガス消費によるガス流速の低減が抑制される。早められたガス流速によって、ガス流路２７、２８の途中にたまった水の、該水より下流側にある、ガス出口２７ｃ、２８ｃまたは排水通路３０、３１への排水性がよくなり、湿潤過多、フラッディングが防止される。

【００２３】また、酸化ガス流路２８で酸化ガスが下方から上方に流れ、冷媒流路２６で冷媒が下方から上方に流れる場合は、最も乾きやすい酸化ガス流路入口近傍の温度を最も下げることができ、酸化ガス流路入口近傍の飽和蒸気圧を下げてその近傍の電解質膜１１を乾きにくくすることができる。また、冷媒流路２６内に気泡が生じても、浮力によって上方にある冷媒出口へと向かうので、冷媒流路の気泡（ガス溜まり）によるガスロックを防止することができる。冷媒を上から入れて下に流すとガス溜まりができた時にガスロックしうるが、それを防止することができる。

【００２４】つぎに、本発明の各実施例に特有な部分を説明する。本発明の実施例１では、同じ方向からセパレータ面を見た図５に示すように、燃料ガス（水素）は燃料ガス流路２７を上から下に流れ、酸化ガス（空気）は酸化ガス流路２８を下から上に流れ、冷媒（冷却水）は冷媒流路２６を下から上に流れる。燃料ガスと酸化ガスは逆方向に流れ、酸化ガスと冷媒は同じ方向に流れる。セパレータ面は重力方向にあり、ガス流路、冷媒流路はサーペンタイン流路となっている。酸化ガス流路２８には、ガス入口とガス出口との間の流路途中部分に排水通路３１が設けられている。この構成によって、反応生成水が酸化ガス流路２８に生じても、排水通路３１を介して水を効率よく系外に排出することができる。また、燃料ガスと酸化ガスの対向流によって、水分のセル内循環が可能になり、効率よく、酸化ガス流路のフラッディング防止、電解質膜のドライアップ防止をはかることができる。また、酸化ガスと冷媒の同方向流および下から上

への流れによって、酸化ガス入口近傍の電解質膜のドライアップ防止と冷媒のガスロックの防止をはかることができる。

【００２５】本発明の実施例２では、同じ方向からセパレータ面を見た図６に示すように、燃料ガス（水素）は燃料ガス流路２７を下から上に流れ、酸化ガス（空気）は酸化ガス流路２８を上から下に流れ、冷媒（冷却水）は冷媒流路２６を下から上に流れる。燃料ガスと酸化ガスは逆方向に流れ、燃料ガスと冷媒は同じ方向に流れる。セパレータ面は重力方向にあり、ガス流路、冷媒流路はサーペンタイン流路となっている。酸化ガス流路２８と燃料ガス流路２７の少なくとも一方には、ガス入口とガス出口との間の流路途中部分に排水通路３１が設けられている。この構成によって、反応生成水が生じても、排水通路３１を介して水を効率よく系外に排出することができる。また、燃料ガスと酸化ガスの対向流によって、水分のセル内循環が可能になり、効率よく、酸化ガス流路のフラッディング防止、電解質膜のドライアップ防止をはかることができる。また、冷媒の下から上への流れによって、冷媒のガスロックを防止することができる。

【００２６】

【発明の効果】請求項１の燃料電池によれば、排水通路を設けたので、ガス流路途中の凝縮水を排水通路を介して排出でき、ガス流路からの排水性を改善できる。また、セパレータ面を上下方向に向けたので、たとえガス流路内に水滴が生じても、重力でガス流路を下方に流れ、セル面全域が水分により覆われることは起こらない。請求項２の燃料電池によれば、排水通路にバルブを設けたので、排水時以外はバルブを閉にしておくことにより、ガスが排水通路を介して系外に排出されることを防止でき、かつ排水時も系外に排出されるガス量を制御でき、これらによって、ガス流路におけるガス流速低下を最小限にすることができる。請求項３の燃料電池によれば、燃料電池の運転状態に応じてバルブを開閉制御するバルブ開閉制御装置を設けたので、燃料電池の運転状態に応じた最適な排水を行うことができる。請求項４の燃料電池によれば、下方から上方に流れるガス流路に排水通路を設けたので、水に重力と反対方向にガス流が作用してガス流路の途中に水がたまっても、排水通路により効率よく排水することができる。また、重力とガス流が同じ方向に作用して効率よくガス出口から排水できる流路には、排水通路を必ずしも設けなくてもよく、排水通路によるセル構造の複雑化を最小限にすることができる。請求項５の燃料電池によれば、酸化ガスと燃料ガスをＭＥＡの表裏で互いに対向させて流したので、アノード側とカソード側の反応面における湿度分布が互いに逆分布となり、水分が、電解質膜を通して、酸化ガス出口部近傍から燃料ガス入口部近傍に、さらに燃料ガス出口部近傍から酸化ガス入口部近傍に拡散、移行し、セル内を水分が循環して、水分分布の均一化、フラッディング防止がはかられる。請求項６の燃料電池によれば、ガス流路を上流側から下流側に向けて絞ったので、ガス流速が速くなる、または水生成反応におけるガス消費によるガス流速の低減が抑制される。早められたガス流速によって、ガス流路の途中にたまった水のガス出口または排水通路への排水性がよくなる。請求項７の燃料電池によれば、酸化ガス流路ではガスが下方から上方に流れ、冷媒流路では冷媒が下方から上方に流れるので、最も乾きやすい酸化ガス流路入口近傍の温度を最も下げることができ、酸化ガス流路入口近傍の飽和蒸気圧を下げて乾きにくくすることができる。また、冷媒流路内に気泡が生じても、浮力によって上方にある冷媒出口へと向かうので、冷媒流路の気泡（ガス溜まり）によるガスロックを防止することができる。

【図面の簡単な説明】

【図１】本発明の燃料電池と排水システムの全体概略斜視図である。

【図２】本発明の燃料電池の全体概略図である。

【図３】本発明の燃料電池の一部拡大断面図である。

【図４】本発明の燃料電池のガス流路（たとえば、酸化ガス流路）の正面図である。

【図５】本発明の実施例１の燃料電池の、燃料ガス流路と酸化ガス流路と冷媒流路とをセル面をずらして示した、正面図である。

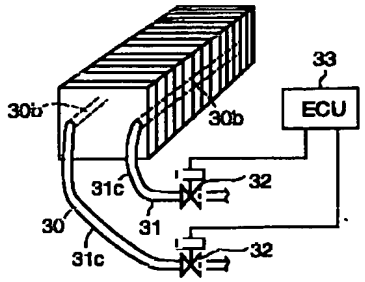
【図６】本発明の実施例２の燃料電池の、燃料ガス流路と酸化ガス流路と冷媒流路とをセル面をずらして示した、正面図である。

【符号の説明】

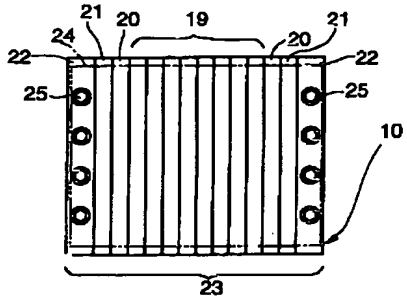
１０　（固体高分子電解質型）燃料電池
１１　電解質膜
１２　触媒層
１３　拡散層
１４　電極（アノード、燃料極）
１５　触媒層
１６　拡散層
１７　電極（カソード、空気極）
１８　セパレータ
１９　モジュール
２０　ターミナル
２１　インシュレータ
２２　エンドプレート
２３　スタック
２４　テンションプレート
２５　ボルト
２６　冷媒流路
２７　燃料ガス流路
２７ａ　燃料ガス流路
２７ｂ　燃料ガス流路入口
２７ｃ　燃料ガス流路出口

２８　酸化ガス流路
２８ａ　酸化ガス流路
２８ｂ　酸化ガス流路入口
２８ｃ　酸化ガス流路出口
２９　仕切壁
３０、３１　排水通路
３２　バルブ
３３　バルブ開閉制御装置

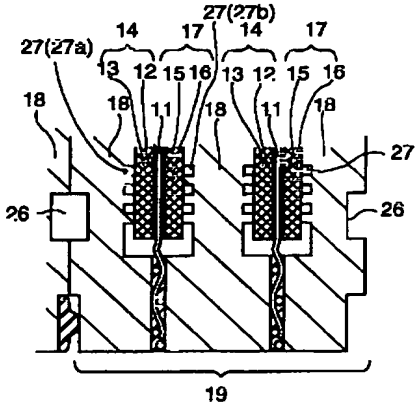
【図１】



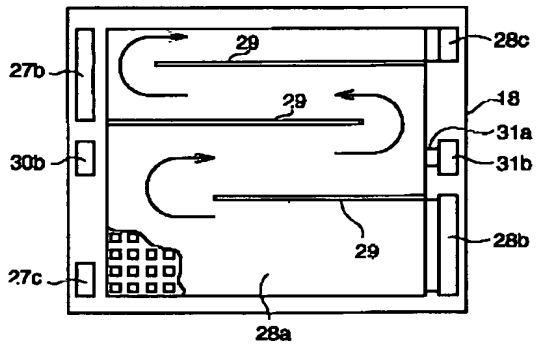
【図２】



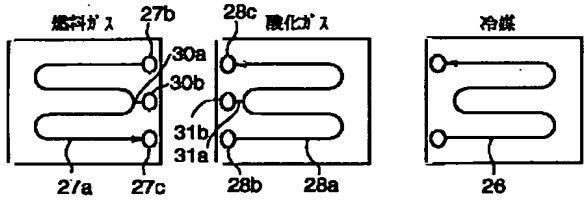
【図３】



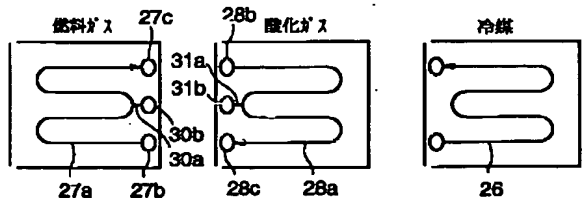
【図４】



【図５】



【図６】



フロントページの続き

(72)発明者　浅井　康之
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内

Ｆターム(参考)　5H026 AA06 CC03 CC08 CC10 HH03
5H027 AA06 CC06 MM03 MM08

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-198069
(43)Date of publication of application : 12.07.2002

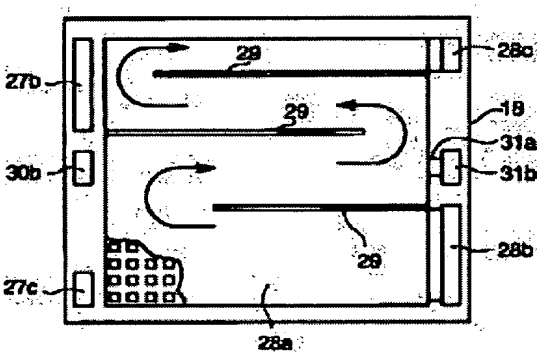
(51)Int.Cl. H01M 8/02
H01M 8/06
H01M 8/10

(21)Application number : 2000-392177
(22)Date of filing : 25.12.2000

(71)Applicant : TOYOTA MOTOR CORP
(72)Inventor : TAKAHASHI TAKESHI
SUZUKI TOSHIYUKI
ASAI YASUYUKI

(54) FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel cell with improved drainage of condensed water at a gas flow path.
SOLUTION: (1) With the fuel cell 10 with faces of a separator 18 directed upward and downward and equipped with gas flow passages 27, 28 for oxidized or fuel gas at a contact face of the separator with an electrode, drainage passes 30, 31 capable of draining water trapped in the gas flow passage out of the fuel cell are fitted at places other than a gas inlet and a gas outlet of the gas flow passages 27, 28. (2) The fuel cell is provided with a switching valve 32 at the drainage paths 30, 31. (3) The fuel cell is provided with a valve switching control device 33 which controls opening and closing of the valve 32 according to an operation state of the fuel cell. (4) The fuel cell is equipped with the drainage passes 30, 31 at that gas flow path in which gas flows upward from bottom out of the gas flow passages for oxidized gas or fuel gas.



* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]In a fuel cell which turned a separator surface to a sliding direction and provided a gas passageway of oxidizing gas or fuel gas in a contact surface with an electrode of a separator, A fuel cell carrying out the opening of the drainage channel which can be discharged out of a fuel cell for water which collects on a gas passageway to an intermediate position other than a gas inlet of said gas passageway, and a gas outlet.
[Claim 2]The fuel cell according to claim 1 which provided a valve which can be opened and closed to said drainage channel.
[Claim 3]The fuel cell according to claim 2 which formed a valve opening and closing control device which carries out opening and closing control of said valve according to operational status of a fuel cell.
[Claim 4]The fuel cell according to claim 1 which established said drainage channel in a gas passageway through which gas flows into the upper part from a lower part among gas passagewaies of oxidizing gas or fuel gas.
[Claim 5]The fuel cell according to claim 4 which established said drainage channel in a gas passageway through which gas flows through into the upper part from a lower part by one gas passageway among gas passagewaies of oxidizing gas or fuel gas, gas flows through caudad from the upper part in a gas passageway of another side, and said gas flows into the upper part from a lower part.
[Claim 6]The fuel cell according to claim 1 which turned a gas passageway downstream and extracted it from the upper stream.
[Claim 7]The fuel cell according to claim 1 with which has a refrigerant passage, gas flows into the upper part from a lower part in an oxidizing gas passage, and a refrigerant flows into the upper part from a lower part in a refrigerant passage.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]Especially this invention relates to the fuel cell which made good discharge of the produced water of a solid polyelectrolyte type fuel cell about a fuel cell.
[0002]
[Description of the Prior Art]the electrode (an anode.) which consists of the catalyst bed and diffusion zone which have been arranged at the whole surface of the electrolyte membrane which a solid polyelectrolyte type fuel cell becomes from an ion-exchange membrane, and this electrolyte membrane with the film-electrode assembly (MEA:Membrane-Electrode Assembly) which consists of an electrode (a cathode, an air pole) which consists of the catalyst bed and diffusion zone of a fuel electrode and an electrolyte membrane which were alike on the other hand and have been arranged. A cell is constituted from a separator which forms the fluid channel for supplying fuel gas (hydrogen) and oxidizing gas (oxygen, usually air) to an anode and a cathode, Laminate two or more cells, consider it as a module, laminate a module, and a module group is constituted, A terminal, an insulator, and an end plate are arranged to the cell laminating direction both ends of a module group, and a stack is constituted, and a stack is bound tight in the fastening member (for example, tension plate) prolonged in a cell layered product laminating direction, and it consists of what was fixed. In a solid polyelectrolyte type fuel cell, in the anode side. The reaction which uses hydrogen as a hydrogen ion and an electron is performed, a hydrogen ion moves the inside of an electrolyte membrane to the cathode side, and the reaction which generates water from oxygen, a hydrogen ion, and an electron (the electron generated with the anode of the next MEA lets a separator pass) is performed in the cathode side.
anode side: -- H_2 __ ->$2H^+$+$2e^-$ cathode side:, since the temperature of a cell rises with the heat and Joule heat which come out by the water generation reaction in a $2H^+$+$2e^-$ +(1/2) O_2- >H_2O cathode, between separators -- every cell -- or the refrigerant passage through which a refrigerant (usually cooling water) flows is formed for two or more cells of every.
The fuel cell is cooled.
Humidity of the oxidizing gas is carried out with produced water on the way that it is easy to dry by an entrance side (dry), and it tends to produce the excess (flooding) of humid in an outlet side. Since the moisture of oxidizing gas diffuses fuel gas through an electrolyte membrane, the fuel gas outlet side will be in a damp or wet condition from an entrance side. In order for a hydrogen ion to shift the inside of an electrolyte membrane with a fuel cell and to perform the above-mentioned power generation reaction smoothly, the electrolyte membrane must contain moderate moisture. In order to perform a normal power generation reaction throughout an electrolyte membrane, it is required for moisture distribution to be equalized by cell face inboard. If it becomes what, it will be because the above-mentioned power generation reaction will no longer be obtained if moisture distribution inclines and an electrolyte membrane dries locally, and will be because supply of oxygen to the cathode of oxidizing gas will be prevented by generation and the condensed waterdrop if it becomes excessive humid with the produced water by a reaction. JP,2000-82482,A is indicating the polymer electrolyte fuel cell in which the water of

condensation has a Serpentine (meandering) type gas supply channel which may be discharged by the outflow direction according to the air current from a gas stream ON hole to an effluence-of-gas hole.

[0003]

[Problem(s) to be Solved by the Invention]However, in the above-mentioned conventional fuel cell, if a gas passageway becomes long, it will become difficult for the water of condensation to reach to a discharge hole. In a separator with the gas passageway in which the inclination that the self weight falling of the water of condensation can be carried out especially to a discharge hole is not established, the drainage aggravation becomes remarkable. The purpose of this invention is to provide the fuel cell which has improved the wastewater nature of the water of condensation of a gas passageway.

[0004]

[Means for Solving the Problem]This invention which attains the above-mentioned purpose is as follows.

(1) In a fuel cell which turned a separator surface to a sliding direction and provided a gas passageway of oxidizing gas or fuel gas in a contact surface with an electrode of a separator, A fuel cell carrying out the opening of the drainage channel which can be drained out of a fuel cell for water which collects on a gas passageway to an intermediate position other than a gas inlet of said gas passageway, and a gas outlet.

(2) A fuel cell given in (1) which provided a valve which can be opened and closed to said drainage channel.

(3) A fuel cell given in (2) which formed a valve opening and closing control device which carries out opening and closing control of said valve according to operational status of a fuel cell.

(4) A fuel cell given in (1) which established said drainage channel in a gas passageway through which gas flows into the upper part from a lower part among gas passagewaies of oxidizing gas or fuel gas.

(5) A fuel cell given in (1) which established said drainage channel in a gas passageway through which gas flows through into the upper part from a lower part by one gas passageway among gas passagewaies of oxidizing gas or fuel gas, gas flows through caudad from the upper part in a gas passageway of another side, and said gas flows into the upper part from a lower part.

(6) The fuel cell according to claim 1 which turned a gas passageway downstream and extracted it from the upper stream.

(7) The fuel cell according to claim 1 with which has a refrigerant passage, gas flows into the upper part from a lower part in an oxidizing gas passage, and a refrigerant flows into the upper part from a lower part in a refrigerant passage.

[0005]In a fuel cell of the above (1), since a drainage channel was established, the water of condensation can be discharged via a drainage channel, and wastewater nature can be improved. Since a separator surface was turned to a sliding direction, even if waterdrop arises in a gas passageway, it will flow through a gas passageway caudad by gravity, and it will not happen that the cell face whole region is covered with moisture. In a fuel cell of the above (2), since a valve was provided in a drainage channel, by making a valve close except the time of wastewater, Gas can be prevented from being discharged out of a system via a drainage channel, and gas volume discharged out of a system can be controlled also at the time of wastewater, and a gas flow rate fall in a gas passageway can be made into the minimum by these. In a fuel cell of the above (3), since a valve opening and closing control device which carries out opening and closing control of the valve according to operational status of a fuel cell was formed, optimal wastewater according to operational status of a fuel cell can be performed. In a fuel cell of the above (4), since a drainage channel was established in a gas passageway which flows into the upper part from a lower part, even if a gas stream acts on water in gravity and a counter direction and water accumulates in the middle of a gas passageway, it can drain efficiently according to a drainage channel. It is not necessary to necessarily establish a drainage channel in a channel which gravity and a gas stream act in the same direction, and can drain from a gas outlet efficiently, and complication of the cellular structure by a drainage channel can be made into the minimum. Since oxidizing gas and fuel gas were made to counter mutually and were passed by a rear

surface of MEA in a fuel cell of the above (4) in a fuel cell of the above (5), In addition to an operation of the above (4), humidity distribution in a reaction surface by the side of an anode and a cathode turns into inverted distribution mutually, and moisture lets an electrolyte membrane pass, Near the fuel gas inlet part from from near the oxidizing gas exit part, spread and shift near the fuel gas outlet part further near the oxidizing gas inlet section (the neighborhood of an oxidizing gas inlet section is a part which gets dry easiliest), and moisture circulates through inside of a cell, Operation that equalization of moisture distribution and flooding prevention (flooding prevention near [which becomes excess of humid most] the oxidizing gas exit part) are aimed at is obtained. In a fuel cell of the above (6), since a gas passageway was turned to the downstream and extracted from the upstream, a gas flow rate becomes quick or reduction of a gas flow rate by gas consumption in a water generation reaction is controlled. By a gas flow rate brought forward, wastewater nature to a gas outlet or a drainage channel which is in the downstream from this water of water which accumulated in the middle of a gas passageway becomes good. It can be made hard to be able to lower most temperature near [which gets dry easiliest] the oxidizing gas passage entrance, to drop maximum vapor tension near the oxidizing gas passage entrance, and to get dry in a fuel cell of the above (7), since gas flows into the upper part from a lower part in an oxidizing gas passage and a refrigerant flows into the upper part from a lower part in a refrigerant passage. Since it goes to a refrigerant exit which is up with lift even if air bubbles are formed in a refrigerant passage, a gas lock by air bubbles (defects of gas accumulation) of a refrigerant passage can be prevented. When a refrigerant is put in from a top, are passed downward and defects of gas accumulation are made, a gas lock can be carried out, but it can be prevented.

[0006]

[Embodiment of the Invention]Below, the fuel cell of this invention is explained with reference to drawing 1 – drawing 6. Drawing 1 – drawing 4 can be applied to any working example of this invention, drawing 5 shows working example 1 of this invention, and drawing 6 shows working example 2 of this invention. The same numerals are given to the portion which is common covering all the working example of this invention covering all the working example of this invention. First, the portion which is common covering all the working example of this invention, or a portion applicable in common is explained with reference to drawing 1 – drawing 4. The fuel cell of this invention is the solid polyelectrolyte type fuel cell 10. The fuel cell 10 of this invention is carried, for example in a fuel cell electric vehicle. However, it may be used in addition to a car.

[0007]the electrode 14 (an anode.) which consists of the catalyst bed 12 and the diffusion zone 13 which have been arranged at the whole surface of the electrolyte membrane 11 which consists of ion-exchange membranes, and this electrolyte membrane 11 as the solid polyelectrolyte type fuel cell 10 is shown in drawing 1 and drawing 2the electrode 17 (a cathode.) which consists of the catalyst bed 15 and the diffusion zone 16 of a fuel electrode and the electrolyte membrane 11 which were alike on the other hand and have been arranged The film-electrode assembly (MEA:Membrane-Electrode Assembly) which consists of air poles, The reactant gas channel 27 (only) for supplying fuel gas (hydrogen) and oxidizing gas (oxygen, usually air) to the electrodes 14 and 17 A cell is formed for the separator 18 which forms the refrigerant passage 26 (it is also called a circulating-water-flow way) through which the refrigerant for fuel cell cooling (usually cooling water) flows and it also calls it a gas passageway in piles, Carry out the plural laminates of this cell, consider it as the module 19, laminate the module 19, and a module group is constituted, To the cell laminating direction (fuel cell laminating direction) both ends of module 19 group, arrange the terminal 20, the insulator 21, and the end plate 22, and the stack 23 is constituted to them, The fastening member 24 (for example) which binds the stack 23 tight to a laminating direction and is prolonged in a fuel cell layered product laminating direction on the outside of the stack 23 It consists of what was fixed with the tension plate and the bolt 25.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention]Especially this invention relates to the fuel cell which made good discharge of the produced water of a solid polyelectrolyte type fuel cell about a fuel cell.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

PRIOR ART

[Description of the Prior Art]the electrode (an anode.) which consists of the catalyst bed and diffusion zone which have been arranged at the whole surface of the electrolyte membrane which a solid polyelectrolyte type fuel cell becomes from an ion-exchange membrane, and this electrolyte membrane with the film-electrode assembly (MEA:Membrane-Electrode Assembly) which consists of an electrode (a cathode, an air pole) which consists of the catalyst bed and diffusion zone of a fuel electrode and an electrolyte membrane which were alike on the other hand and have been arranged. A cell is constituted from a separator which forms the fluid channel for supplying fuel gas (hydrogen) and oxidizing gas (oxygen, usually air) to an anode and a cathode, Laminate two or more cells, consider it as a module, laminate a module, and a module group is constituted, A terminal, an insulator, and an end plate are arranged to the cell laminating direction both ends of a module group, and a stack is constituted, and a stack is bound tight in the fastening member (for example, tension plate) prolonged in a cell layered product laminating direction, and it consists of what was fixed. In a solid polyelectrolyte type fuel cell, in the anode side. The reaction which uses hydrogen as a hydrogen ion and an electron is performed, a hydrogen ion moves the inside of an electrolyte membrane to the cathode side, and the reaction which generates water from oxygen, a hydrogen ion, and an electron (the electron generated with the anode of the next MEA lets a separator pass) is performed in the cathode side.
anode side: -- H_2 __ ->$2H^+$+$2e^-$ cathode side:, since the temperature of a cell rises with the heat and Joule heat which come out by the water generation reaction in a $2H^+$+$2e^-$ +(1/2) O_2->H_2O cathode, between separators -- every cell -- or the refrigerant passage through which a refrigerant (usually cooling water) flows is formed for two or more cells of every.
The fuel cell is cooled.
Humidity of the oxidizing gas is carried out with produced water on the way that it is easy to dry by an entrance side (dry), and it tends to produce the excess (flooding) of humid in an outlet side. Since the moisture of oxidizing gas diffuses fuel gas through an electrolyte membrane, the fuel gas outlet side will be in a damp or wet condition from an entrance side. In order for a hydrogen ion to shift the inside of an electrolyte membrane with a fuel cell and to perform the above-mentioned power generation reaction smoothly, the electrolyte membrane must contain moderate moisture. In order to perform a normal power generation reaction throughout an electrolyte membrane, it is required for moisture distribution to be equalized by cell face inboard. If it becomes what, it will be because the above-mentioned power generation reaction will no longer be obtained if moisture distribution inclines and an electrolyte membrane dries locally, and will be because supply of oxygen to the cathode of oxidizing gas will be prevented by generation and the condensed waterdrop if it becomes excessive humid with the produced water by a reaction. JP,2000-82482,A is indicating the polymer electrolyte fuel cell in which the water of condensation has a Serpentine (meandering) type gas supply channel which may be discharged by the outflow direction according to the air current from a gas stream ON hole to an effluence-of-gas hole.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]Since the drainage channel was established according to the fuel cell of Claim 1, the water of condensation in the middle of a gas passageway can be discharged via a drainage channel, and the wastewater nature from a gas passageway can be improved. Since the separator surface was turned to the sliding direction, even if waterdrop arises in a gas passageway, it will flow through a gas passageway caudad by gravity, and it will not happen that the cell face whole region is covered with moisture. Since the valve was provided in the drainage channel according to the fuel cell of Claim 2, by making the valve close except the time of wastewater, Gas can be prevented from being discharged out of a system via a drainage channel, and the gas volume discharged out of a system can be controlled also at the time of wastewater, and the gas flow rate fall in a gas passageway can be made into the minimum by these. Since the valve opening and closing control device which carries out opening and closing control of the valve according to the operational status of a fuel cell was formed according to the fuel cell of Claim 3, optimal wastewater according to the operational status of the fuel cell can be performed. Since the drainage channel was established in the gas passageway which flows into the upper part from a lower part according to the fuel cell of Claim 4, even if a gas stream acts on water in gravity and a counter direction and water accumulates in the middle of a gas passageway, it can drain efficiently according to a drainage channel. It is not necessary to necessarily establish a drainage channel in the channel which gravity and a gas stream act in the same direction, and can drain from a gas outlet efficiently, and complication of the cellular structure by a drainage channel can be made into the minimum. Since according to the fuel cell of Claim 5 oxidizing gas and fuel gas were made to counter mutually and were passed by the rear surface of MEA, The humidity distribution in the reaction surface by the side of an anode and a cathode turns into inverted distribution mutually, and moisture lets an electrolyte membrane pass, Near the fuel gas inlet part from from near the oxidizing gas exit part, it spreads and shifts near the oxidizing gas inlet section near the fuel gas outlet part further, moisture circulates through the inside of a cell, and equalization of moisture distribution and flooding prevention are aimed at. Since according to the fuel cell of Claim 6 the gas passageway was turned to the downstream and extracted from the upstream, a gas flow rate becomes quick or reduction of the gas flow rate by the gas consumption in a water generation reaction is controlled. By the gas flow rate brought forward, the wastewater nature to the gas outlet or drainage channel of the water which accumulated in the middle of the gas passageway becomes good. It can be made hard to be able to lower most the temperature near [which gets dry easiliest] the oxidizing gas passage entrance, to drop the maximum vapor tension near the oxidizing gas passage entrance, and to get dry, since according to the fuel cell of Claim 7 gas flows into the upper part from a lower part in an oxidizing gas passage and a refrigerant flows into the upper part from a lower part in a refrigerant passage. Since it goes to the refrigerant exit which is up with lift even if air bubbles are formed in a refrigerant passage, the gas lock by the air bubbles (defects of gas accumulation) of a refrigerant passage can be prevented.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, in the above-mentioned conventional fuel cell, if a gas passageway becomes long, it will become difficult for the water of condensation to reach to a discharge hole. In a separator with the gas passageway in which the inclination that the self weight falling of the water of condensation can be carried out especially to a discharge hole is not established, the drainage aggravation becomes remarkable. The purpose of this invention is to provide the fuel cell which has improved the wastewater nature of the water of condensation of a gas passageway.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem]This invention which attains the above-mentioned purpose is as follows.
(1) In a fuel cell which turned a separator surface to a sliding direction and provided a gas passageway of oxidizing gas or fuel gas in a contact surface with an electrode of a separator, A fuel cell carrying out the opening of the drainage channel which can be drained out of a fuel cell for water which collects on a gas passageway to an intermediate position other than a gas inlet of said gas passageway, and a gas outlet.
(2) A fuel cell given in (1) which provided a valve which can be opened and closed to said drainage channel.
(3) A fuel cell given in (2) which formed a valve opening and closing control device which carries out opening and closing control of said valve according to operational status of a fuel cell.
(4) A fuel cell given in (1) which established said drainage channel in a gas passageway through which gas flows into the upper part from a lower part among gas passagewaies of oxidizing gas or fuel gas.
(5) A fuel cell given in (1) which established said drainage channel in a gas passageway through which gas flows through into the upper part from a lower part by one gas passageway among gas passagewaies of oxidizing gas or fuel gas, gas flows through caudad from the upper part in a gas passageway of another side, and said gas flows into the upper part from a lower part.
(6) The fuel cell according to claim 1 which turned a gas passageway downstream and extracted it from the upper stream.
(7) The fuel cell according to claim 1 with which has a refrigerant passage, gas flows into the upper part from a lower part in an oxidizing gas passage, and a refrigerant flows into the upper part from a lower part in a refrigerant passage.
[0005]In a fuel cell of the above (1), since a drainage channel was established, the water of condensation can be discharged via a drainage channel, and wastewater nature can be improved. Since a separator surface was turned to a sliding direction, even if waterdrop arises in a gas passageway, it will flow through a gas passageway caudad by gravity, and it will not happen that the cell face whole region is covered with moisture. In a fuel cell of the above (2), since a valve was provided in a drainage channel, by making a valve close except the time of wastewater, Gas can be prevented from being discharged out of a system via a drainage channel, and gas volume discharged out of a system can be controlled also at the time of wastewater, and a gas flow rate fall in a gas passageway can be made into the minimum by these. In a fuel cell of the above (3), since a valve opening and closing control device which carries out opening and closing control of the valve according to operational status of a fuel cell was formed, optimal wastewater according to operational status of a fuel cell can be performed. In a fuel cell of the above (4), since a drainage channel was established in a gas passageway which flows into the upper part from a lower part, even if a gas stream acts on water in gravity and a counter direction and water accumulates in the middle of a gas passageway, it can drain efficiently according to a drainage channel. It is not necessary to necessarily establish a drainage channel in a channel which gravity and a gas stream act in the same direction, and can drain from a gas outlet efficiently, and complication of the cellular structure by a drainage channel can be made into the minimum.

Since oxidizing gas and fuel gas were made to counter mutually and were passed by a rear surface of MEA in a fuel cell of the above (4) in a fuel cell of the above (5), In addition to an operation of the above (4), humidity distribution in a reaction surface by the side of an anode and a cathode turns into inverted distribution mutually, and moisture lets an electrolyte membrane pass, Near the fuel gas inlet part from from near the oxidizing gas exit part, spread and shift near the fuel gas outlet part further near the oxidizing gas inlet section (the neighborhood of an oxidizing gas inlet section is a part which gets dry easiliest), and moisture circulates through inside of a cell, Operation that equalization of moisture distribution and flooding prevention (flooding prevention near [which becomes excess of humid most] the oxidizing gas exit part) are aimed at is obtained. In a fuel cell of the above (6), since a gas passageway was turned to the downstream and extracted from the upstream, a gas flow rate becomes quick or reduction of a gas flow rate by gas consumption in a water generation reaction is controlled. By a gas flow rate brought forward, wastewater nature to a gas outlet or a drainage channel which is in the downstream from this water of water which accumulated in the middle of a gas passageway becomes good. It can be made hard to be able to lower most temperature near [which gets dry easiliest] the oxidizing gas passage entrance, to drop maximum vapor tension near the oxidizing gas passage entrance, and to get dry in a fuel cell of the above (7), since gas flows into the upper part from a lower part in an oxidizing gas passage and a refrigerant flows into the upper part from a lower part in a refrigerant passage. Since it goes to a refrigerant exit which is up with lift even if air bubbles are formed in a refrigerant passage, a gas lock by air bubbles (defects of gas accumulation) of a refrigerant passage can be prevented. When a refrigerant is put in from a top, are passed downward and defects of gas accumulation are made, a gas lock can be carried out, but it can be prevented.

[0006]

[Embodiment of the Invention]Below, the fuel cell of this invention is explained with reference to drawing 1 – drawing 6. Drawing 1 – drawing 4 can be applied to any working example of this invention, drawing 5 shows working example 1 of this invention, and drawing 6 shows working example 2 of this invention. The same numerals are given to the portion which is common covering all the working example of this invention covering all the working example of this invention. First, the portion which is common covering all the working example of this invention, or a portion applicable in common is explained with reference to drawing 1 – drawing 4. The fuel cell of this invention is the solid polyelectrolyte type fuel cell 10. The fuel cell 10 of this invention is carried, for example in a fuel cell electric vehicle. However, it may be used in addition to a car.

[0007]the electrode 14 (an anode.) which consists of the catalyst bed 12 and the diffusion zone 13 which have been arranged at the whole surface of the electrolyte membrane 11 which consists of ion-exchange membranes, and this electrolyte membrane 11 as the solid polyelectrolyte type fuel cell 10 is shown in drawing 1 and drawing 2the electrode 17 (a cathode.) which consists of the catalyst bed 15 and the diffusion zone 16 of a fuel electrode and the electrolyte membrane 11 which were alike on the other hand and have been arranged The film-electrode assembly (MEA:Membrane-Electrode Assembly) which consists of air poles, The reactant gas channel 27 (only) for supplying fuel gas (hydrogen) and oxidizing gas (oxygen, usually air) to the electrodes 14 and 17 A cell is formed for the separator 18 which forms the refrigerant passage 26 (it is also called a circulating-water-flow way) through which the refrigerant for fuel cell cooling (usually cooling water) flows and it also calls it a gas passageway in piles, Carry out the plural laminates of this cell, consider it as the module 19, laminate the module 19, and a module group is constituted, To the cell laminating direction (fuel cell laminating direction) both ends of module 19 group, arrange the terminal 20, the insulator 21, and the end plate 22, and the stack 23 is constituted to them, The fastening member 24 (for example) which binds the stack 23 tight to a laminating direction and is prolonged in a fuel cell layered product laminating direction on the outside of the stack 23 It consists of what was fixed with the tension plate and the bolt 25.

[0008]The fuel cell 10 is perpendicularly arranged by making a cell laminating direction into gravity. Therefore, the cell face and the separator surface are turned in the perpendicular

direction (sliding direction). The refrigerant passage 26 is formed for every cell or two or more cells of every. For example, the one refrigerant passage 26 is formed every two cells. A refrigerant, for example, cooling water, flows into the refrigerant passage 26.
[0009]The separator 18 forms the electric passage through which an electron flows into a cathode from the anode of an adjacent cell while dividing any of fuel gas, oxidizing gas and fuel gas, cooling water and oxidizing gas, and cooling water ** they are. That by which the separator 18 formed the refrigerant passage 26 and the gas passageway 27 in the carbon plate, Or it consists of either of the thing ** which laid [with the unevenness which forms the thing in which the refrigerant passage 26 and the gas passagewaies 27 and 28 were formed or the refrigerant passage 26, and the gas passagewaies 27 and 28 / of it / the metal plate or it] on top of the resin board which mixed the conductive particle and gave conductivity. Each gas passagewaies 27 and 28 may be the spaces (lattice-like channel) between the plates of two sheets separated by two or more projections like the example of a graphic display, and may be gas-passageway groups which consist of two or more gas passagewaies which are mutually parallel. However, the point of wastewater nature to a lattice-like channel is desirable. In order that the gas passagewaies 27 and 28 may earn channel length and the rate of flow, it consists of a Serpentine (meandering) channel, and except for the clinch part of a channel, a channel is level, or it extends in level or a sliding direction, and, as for an adjoining channel, it is almost desirable to be divided with the bridge wall 29 except for the clinch part of a channel.
[0010]The gas passagewaies 27 and 28 consist of the fuel gas flow route 27 into which fuel gas flows, and the oxidizing gas passage 28 through which oxidizing gas flows. The fuel gas flow route 27 is formed in the 1 side of MEA, and the oxidizing gas passage 28 is established in the other sides of MEA. Therefore, the fuel gas flow route 27 and the oxidizing gas passage 28 sandwich MEA, and are located in the rear surface of MEA. the fuel gas flow route 27 of a cell -- the fuel gas flow route 27a, the fuel gas inlet 27b to the fuel gas flow route 27a, the fuel gas outlet 27c from the fuel gas flow route 27a, and **, ** and others the same -- the oxidizing gas passage 28 of a cell -- the oxidizing gas passage 28a, the oxidizing gas entrance 28b to the oxidizing gas passage 28a, the oxidizing gas exit 28c from the oxidizing gas passage 28a, and **, ** and others

[0011]The opening of the drainage channel 30 which can be discharged out of the fuel cell 10 is carried out to the intermediate position other than the gas inlet 27b of the gas passageway 27, and gas outlet 27c in the water which collects on the gas passageway 27a. Similarly, the opening of the drainage channel 31 which can be discharged out of the fuel cell 10 is carried out to the intermediate position other than the gas inlet 28b of the gas passageway 28, and gas outlet 28c in the water which collects on the gas passageway 28a. From the gas passagewaies 27a and 28a, the drainage channels 30 and 31 branch and The drain manifold 30b, The branching channels 30a and 31a prolonged to 31b, the drain manifolds 30b and 31b which are prolonged in a cell laminating direction and collect the branching channels 30a and 31a of each cell, and one end connect with the drain manifolds 30b and 31b, and it has the exhaust hose 30c and 31c which the other end connects or opens out of a system.
[0012]The valve 32 which can open and close the drainage channels 30 and 31 is formed in the drainage channels 30 and 31 at the exhaust hose 30c and 31c, for example, and wastewater (wastewater of gas and **) is carried out by opening the valve 32 wide to a certain timing. Although the drainage channels 30 and 31 are mutually-independent, the valve 32 twist system outside may be in common. When making common the exhaust hose 30c and 31c on the valve 32 twist system outside, in order to prevent mixture into hydrogen, exhaust air, or oxygen, the valve 32 of the drainage channels 30 and 31 shifts time, and is made to make it open.
[0013]The valve opening and closing control device 33 which carries out opening and closing control of the valve 32 according to the operational status of the fuel cell 10 is formed. The valve opening and closing control device 33 consists of ECUs (Electronic Control Unit), for example. ECU Time (for example, it extracts for every fixed time), the operating condition of a fuel cell, Load (an interval will be lengthened if load is small), humidity (the timing of a scupper is brought forward in case of humidity size), a pressure (since the rate of flow is quick and the one where a pressure is lower tends to drain water) the timing of a scupper may be long --

temperature (since it will be easy to condense if cell temperature is low) From the maps beforehand set up by bringing the open timing of the valve 32 forward etc., or these data, amount of water is computed, the valve 32 is opened to proper timing, and the water within a separator surface is drained out of a system. Since gas is also discharged by valve 32 open one, the produced water in the gas passageway 27 and 28 is discharged by the increase of the rate of flow of the gas passagewaies 27 and 28, and it, supply of the gas to an electrode is improved, and the performance of the fuel cell 10 is improved for a moment.

[0014]The drainage channels 30 and 31 are established in the gas passageway (gas passageway which has a gas inlet below a gas outlet) through which gas flows into the upper part from a lower part among the fuel gas flow route 27 or the oxidizing gas passage 28. However, the drainage channels 30 and 31 may be established also in the gas passageway into which gas flows caudad from the upper part. For example, by one gas passageway, gas flows into the upper part from a lower part among the gas passagewaies 27 and 28 of oxidizing gas or fuel gas, In the gas passageway of another side, when gas flows caudad from the upper part, the drainage channels 30 and 31 are established in the gas passageway (gas passageway which has a gas inlet below a gas outlet) through which gas flows into the upper part from a lower part.

[0015]The fuel gas flow route 27 or the oxidizing gas passage 28 is also extracted from the upper stream towards the lower stream. Since fuel gas and oxidizing gas are consumed along with generation of produced water, Since a gas flow rate tries to become slow as it goes to the downstream by a gas passageway, the passage sectional areas of the gas passagewaies 27 and 28 are extracted gradually or gradually towards the downstream so that the fall of a gas flow rate may be lessened or a gas flow rate may be gathered conversely. A diaphragm of these passage sectional areas is acquired by turning the width of the gas passageway 27, or the depth to the downstream, and making it smallness gradually or gradually.

[0016]So that the flow of a refrigerant may not bar it, when gas surfaces with lift in the refrigerant passage 26 to prevent the gas lock (phenomenon in which a channel will be blockaded by the gas produced or mixed in the refrigerant passage 26, and a refrigerant will not flow) of the refrigerant passage 26, What a refrigerant is poured for upwards from the bottom (a refrigerant inlet is below a refrigerant exit) is desirable in the refrigerant passage 26. However, a refrigerant may be poured from a top to the bottom. When a refrigerant is poured upwards from the bottom, it is desirable to also pass oxidizing gas upwards from the bottom. By doing so, an oxidizing gas entrance and a refrigerant inlet can be made to be able to respond, the oxidizing gas entrance which gets dry easiliest can be cooled with a low-temperature refrigerant, the maximum vapor tension near the oxidizing gas entrance can be dropped, and the dry rise of the electrolyte membrane of the neighborhood can be controlled. However, the flow direction of a refrigerant and the flow direction of oxidizing gas may be made to counter.

[0017]As for the flow direction of fuel gas and oxidizing gas, countering mutually is desirable. That is, the feed hopper 27b of fuel gas, the outlet 27c, the gas passageway 27a and the feed hopper 28b of oxidizing gas, the outlet 28c, and the gas passageway 28a are arranged so that the humidity distribution in the reaction surface by the side of an anode and a cathode may turn into inverted distribution mutually. The fuel gas flow route 27a and the oxidizing gas passage 28a of a cell are mutually parallel. And the upstream (it is the fuel gas flow direction upstream from the halfway point of the fuel gas flow route 27a) of the fuel gas flow route 27a of a cell and the downstream (it is the oxidizing gas flow direction downstream from the halfway point of the oxidizing gas passage 28a) of the oxidizing gas passage 28a make it correspond, and it is provided, The downstream (it is the fuel gas flow direction downstream from the halfway point of the fuel gas flow route 27a) of the fuel gas flow route 27a of a cell and the upstream (it is the oxidizing gas flow direction upstream from the halfway point of the oxidizing gas passage 28a) of the oxidizing gas passage 28a make it correspond, and it is provided.

[0018]An operation of the above-mentioned composition in which community or application in all the working example of this invention is possible is explained. Since the drainage channels 30 and 31 were established, the valve 32 can be made open to a certain timing, the water of condensation in the middle of the gas passagewaies 27 and 28 can be discharged out of a system via the drainage channels 30 and 31, and wastewater nature can be improved. By this,

continuous running with the sufficient output performance of the fuel cell 10 becomes possible. Since the separator surface was turned to the sliding direction, even if waterdrop arises in a gas passageway, it flows through a gas passageway caudad by gravity, and eccritic nature will be good and the situation where the cell face whole region which may happen when horizontal arrangement of the cell face is carried out is covered with moisture will not arise.

[0019]By making the valve 32 close except the wastewater execution time, since the valve 32 was formed in the drainage channels 30 and 31, Fuel gas and oxidizing gas can be prevented from being discharged out of a system via a drainage channel, and the gas volume discharged out of a system can be controlled also at the time of wastewater, and the gas flow rate fall in the gas passagewaies 27 and 28 can be made into the minimum by these. Since opening and closing control of the valve 32 is carried out according to the operational status of a fuel cell by the valve opening and closing control device 33, optimal wastewater according to the operational status of the fuel cell can be performed.

[0020]Since a gas stream acts on the water produced in the gas passageway in gravity and a counter direction when gas establishes a drainage channel in the gas passageway which flows into the upper part from a lower part, it water-ball-comes to be easy in the middle of a gas passageway, but even if water accumulates in the middle of a gas passageway, it can drain efficiently according to the drainage channels 30 and 31. To the gas passageway which gravity and a gas stream act in the same direction, and can drain from a gas outlet efficiently. It is not necessary to necessarily establish a drainage channel, and complication (since a drain manifold must be provided, the space in which a gas manifold and a refrigerant manifold are formed should be restricted, and structure should be complicated) of the cellular structure by having established the drainage channel can be made into the minimum.

[0021]When oxidizing gas and fuel gas are made to counter mutually and are passed by the rear surface of MEA, The humidity distribution in the reaction surface by the side of an anode and a cathode turns into inverted distribution mutually, and moisture lets the electrolyte membrane 11 pass, Near the fuel gas inlet part from from near the oxidizing gas exit part, spread and shift near the fuel gas outlet part further near the oxidizing gas inlet section (the neighborhood of an oxidizing gas inlet section is a part which gets dry easiliest), and moisture circulates through the inside of a cell, Equalization of moisture distribution and flooding prevention (flooding prevention near [which becomes excess of humid most] the oxidizing gas exit part) are aimed at.

[0022]Since the gas passagewaies 27 and 28 are extracted from the upstream towards the downstream, a gas flow rate becomes quick or reduction of the gas flow rate by the gas consumption in a water generation reaction is controlled. By the gas flow rate brought forward, from this water of the water which accumulated in the middle of the gas passagewaies 27 and 28, the wastewater nature to the gas outlets 27c and 28c or the drainage channels 30 and 31 in the downstream becomes good, and the excess of humid and flooding are prevented.

[0023]When oxidizing gas flows into the upper part from a lower part in the oxidizing gas passage 28 and a refrigerant flows into the upper part from a lower part in the refrigerant passage 26, It can be made hard to be able to lower most the temperature near [which gets dry easiliest] the oxidizing gas passage entrance, to drop the maximum vapor tension near the oxidizing gas passage entrance, and to get dry in the electrolyte membrane 11 of the neighborhood. Since it goes to the refrigerant exit which is up with lift even if air bubbles are formed in the refrigerant passage 26, the gas lock by the air bubbles (defects of gas accumulation) of a refrigerant passage can be prevented. When a refrigerant is put in from a top, are passed downward and defects of gas accumulation are made, a gas lock can be carried out, but it can be prevented.

[0024]Below, a portion peculiar to each working example of this invention is explained. In working example 1 of this invention, as shown in drawing 5 which looked at the separator surface from the same direction, fuel gas (hydrogen) flows through the fuel gas flow route 27 downward from a top, oxidizing gas (air) flows through the oxidizing gas passage 28 upwards from the bottom, and a refrigerant (cooling water) flows through the refrigerant passage 26 upwards from the bottom. Fuel gas and oxidizing gas flow into an opposite direction, and oxidizing gas and a refrigerant flow in the same direction. A separator surface is located in a gravity direction and the gas passageway and the refrigerant passage are the Serpentine channel. The drainage channel 31 is

established in the oxidizing gas passage 28 at the portion in the middle of the channel between a gas inlet and a gas outlet. By this composition, even if produced water arises in the oxidizing gas passage 28, water can be efficiently discharged out of a system via the drainage channel 31. According to the countercurrent flow of fuel gas and oxidizing gas, the circulation in a cell of moisture is attained, it is efficient and flooding prevention of an oxidizing gas passage and the prevention from a dry rise of an electrolyte membrane can be aimed at. The prevention from a dry rise of the electrolyte membrane near the oxidizing gas entrance and prevention of the gas lock of a refrigerant can be aimed at by the direction style of oxidizing gas and a refrigerant, and the flow from the bottom to [upper].

[0025]In working example 2 of this invention, as shown in drawing 6 which looked at the separator surface from the same direction, fuel gas (hydrogen) flows through the fuel gas flow route 27 upwards from the bottom, oxidizing gas (air) flows through the oxidizing gas passage 28 downward from a top, and a refrigerant (cooling water) flows through the refrigerant passage 26 upwards from the bottom. Fuel gas and oxidizing gas flow into an opposite direction, and fuel gas and a refrigerant flow in the same direction. A separator surface is located in a gravity direction and the gas passageway and the refrigerant passage are the Serpentine channel. The drainage channel 31 is established in the portion at least at one side of the oxidizing gas passage 28 and the fuel gas flow route 27 in the middle of the channel between a gas inlet and a gas outlet. By this composition, even if produced water arises, water can be efficiently discharged out of a system via the drainage channel 31. According to the countercurrent flow of fuel gas and oxidizing gas, the circulation in a cell of moisture is attained, it is efficient and flooding prevention of an oxidizing gas passage and the prevention from a dry rise of an electrolyte membrane can be aimed at. The gas lock of a refrigerant can be prevented by the flow from under a refrigerant to [upper].

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]They are a fuel cell of this invention, and the whole drainage system outline perspective view.
[Drawing 2]It is the whole fuel cell schematic diagram of this invention.
[Drawing 3]It is a partial expanded sectional view of the fuel cell of this invention.
[Drawing 4]It is a front view of the gas passageway (for example, oxidizing gas passage) of the fuel cell of this invention.
[Drawing 5]It is the front view having shifted the cell face and in which showing the fuel gas flow route, oxidizing gas passage, and refrigerant passage of a fuel cell of this invention. [of working example 1]
[Drawing 6]It is the front view having shifted the cell face and in which showing the fuel gas flow route, oxidizing gas passage, and refrigerant passage of a fuel cell of this invention. [of working example 2]
[Description of Notations]
10 (Solid polymer electrolyte type) Fuel cell
11 Electrolyte membrane
12 Catalyst bed
13 Diffusion zone
14 Electrode (an anode, a fuel electrode)
15 Catalyst bed
16 Diffusion zone
17 Electrode (a cathode, an air pole)
18 Separator
19 Module
20 Terminal
21 Insulator
22 End plate
23 Stack
24 Tension plate
25 Bolt
26 Refrigerant passage
27 Fuel gas flow route
27a Fuel gas flow route
27b Fuel gas flow route entrance
27c Fuel gas flow route exit
28 Oxidizing gas passage
28a Oxidizing gas passage
28b Oxidizing gas passage entrance
28c Oxidizing gas passage exit
29 Bridge wall
30 and 31 Drainage channel

32 Valve
33 Valve opening and closing control device

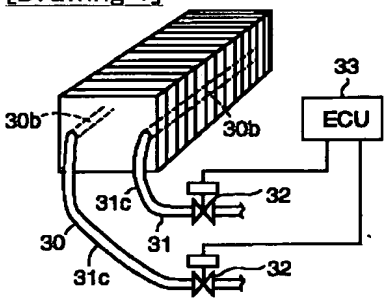
[Translation done.]

* NOTICES *

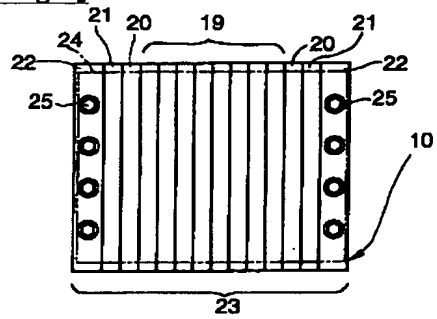
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

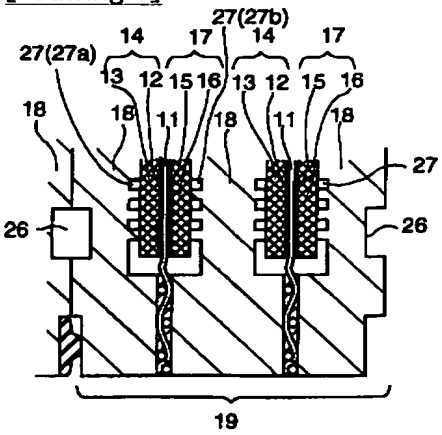
[Drawing 1]



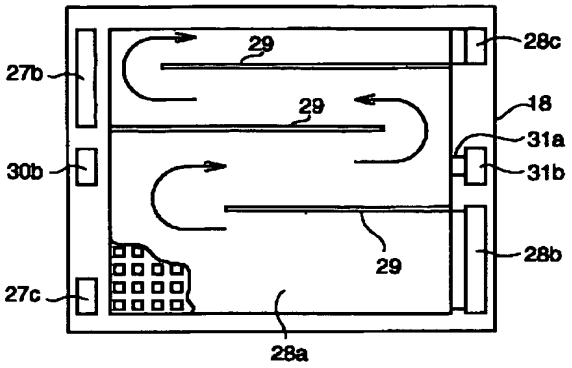
[Drawing 2]



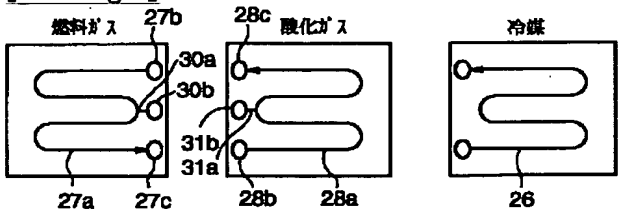
[Drawing 3]



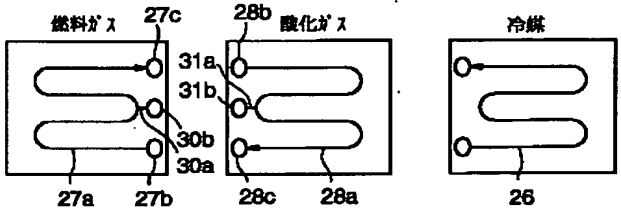
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]